USE OF MUNICIPAL BIOREACTORS FOR TREATMENT OF CONTAMINATED GROUNDWATER

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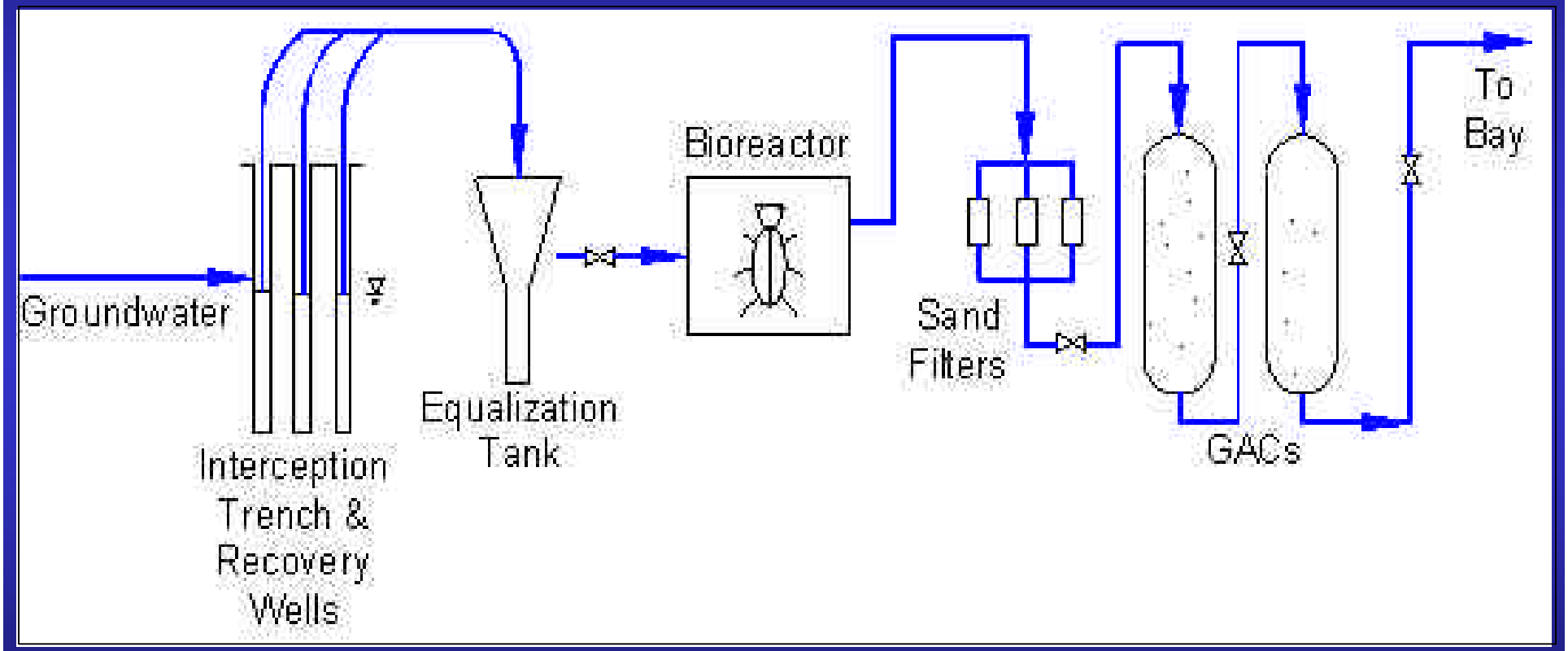
Treatment System Pad

Treatment System Flow Diagram



Bioreactor Selection Criteria

- Matrices/contaminated media
- Aquifer & well field yield
- Influent water quality (contamination and concentration)
- Primary treatment technology
- Process rate/Throughput
- Bioreactor treatment efficiency
- GAC polishing efficiency
- Site conditions/Logistics
- Controls & alarm modems
- Contract lab Vs. Field analysis
- Equipment installation capital costs
- Life cycle costs

Upstream Systems and Process Equipment

System/Equipment	Purpose
Groundwater interception trench	Contain and capture contaminated plume
Groundwater recovery wells	Remove water from trench & deliver to plant, control mounding
Equalization tank	Provide steady-state flow, divert peak over-flow, remove grit
Blower	Supply diffused air to microbes
Nutrient metering pump	Deliver supplemental food to microbes (N_2 and P)

Interception Trench & Recovery Wells

ield lab

Reactor chambers 1 & 2

Down Stream Systems and Process Equipment

System/Equipment	Purpose
Sand filters (three in-parallel)	Remove biomass and solids from reactor effluent
GAC filters (two in-series)	Final polish for Bay discharge
Deep water outfall	Final discharge point into Bay
Phase separator	Remove suspended solids from backwash water
Supplemental storage tank	Polished effluent for backwash and uncontaminated make-up water

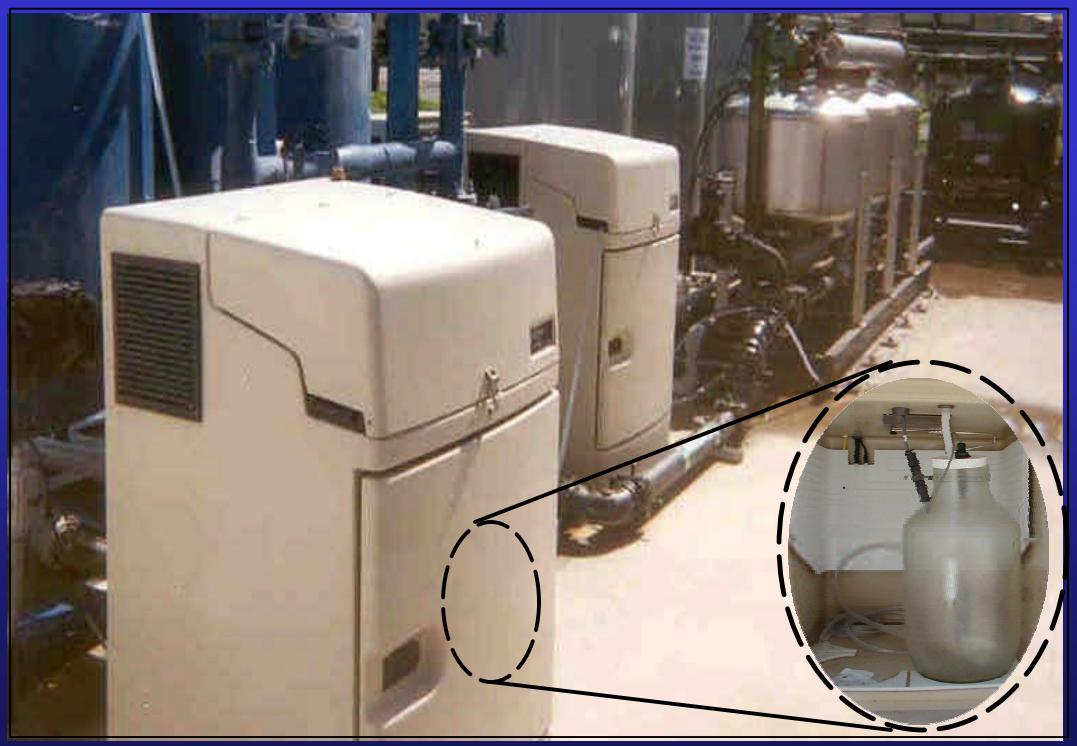
k wash
tank

Daily Monitoring

Dissolved Oxygen (Avg. 2.0 mg/L)
pH (typically 7.5 to 8.5)
Settleable Solids (typically none)
T° (Avg. 17°C, 60°F)

Analytical Monitoring

Total Petroleum Hydrocarbons
Volatile Aromatic Hydrocarbons
Polycyclic Aromatic Hydrocarbons
Fish Toxicity
Cyanide
Metals
Phenols



Routine Maintenance Summary

Maintenance Activity	Frequency	Avg. Down Time
Clean flow control tank components	1 time/week	None to 1 hour
Inspect and lube blowers	1 time/month	None
Refill and adjust reactor nutrient feed	1 time/week and as needed	None
Clean reactor level sensors	1 time/month	None
Clean strainers for sand filter backwash valves	1 time/year	None
Clean/replace geotextile cloth in phase separator	1 time/2 to 4 years	None
Replace GAC media	As needed Year 5: 1 time/year Year 4: 7 times/year Year 3: 2 times/year	48 hours

Operational Problems and Resolutions

Problem	Resolution
Excessive GAC media replacement	• Replace reactor media to increase surface area, maximize contact between microbes and contaminants, reduce excess biomass • Replace spent media in sand filters
Biomass fouling of sand filters	• Optimize microbe nutrients • Change from batch to “near continuous” operation • Use GAC effluent for backwash water
Premature corrosion of stainless steel sand filter vessels	• Replaced vessels with new • Use GAC effluent for backwash water • Revise well field pumping strategy to reduce contribution from saline wells
Increase in test fish mortality	• Revise well field pumping strategy to reduce contribution from saline wells
Scale/mineral deposits within reactor and pipelines	• Removed from reactor chambers and pipelines • Installed cut-of-bypass to ease future cleaning

Two Year Cost-Benefit Analysis

ITEM	UNIT	UNIT COST	OPTION 1: NO CHANGES			OPTION 2: PROPOSED CHANGES		
			QTY	Amount	Total	QTY	Amount	Total
Year 4								
Activated carbon replacements	Each	$1,870	7	$13,090		1	$1,870	
2” solenoid valve on tank effluent	Each	$600	-	-		1	$600	
3” solenoid valve on tank influent	Each	$1,350	-	-		1	$1,350	
Automatic control for backwash tank	Each	$3,000	-	-		1	$3,000	
Labor to install solenoid valves	Hour	$27.00	-	-		16	$432	
Procurement activity	Hour	$27.00	16	$432		18	$486	
Subtotal					$13,522			$7,738
Year 5								
Activated carbon replacement	Each	$1,870	7	$13,090		1	$1,870	
Subtotal					$13,090			$1,870
TOTAL COST					**$26,612**			**$9,608**
ESTIMATED CLIENT SAVINGS								**$17,004**

Three Year O&M and Optimization Costs

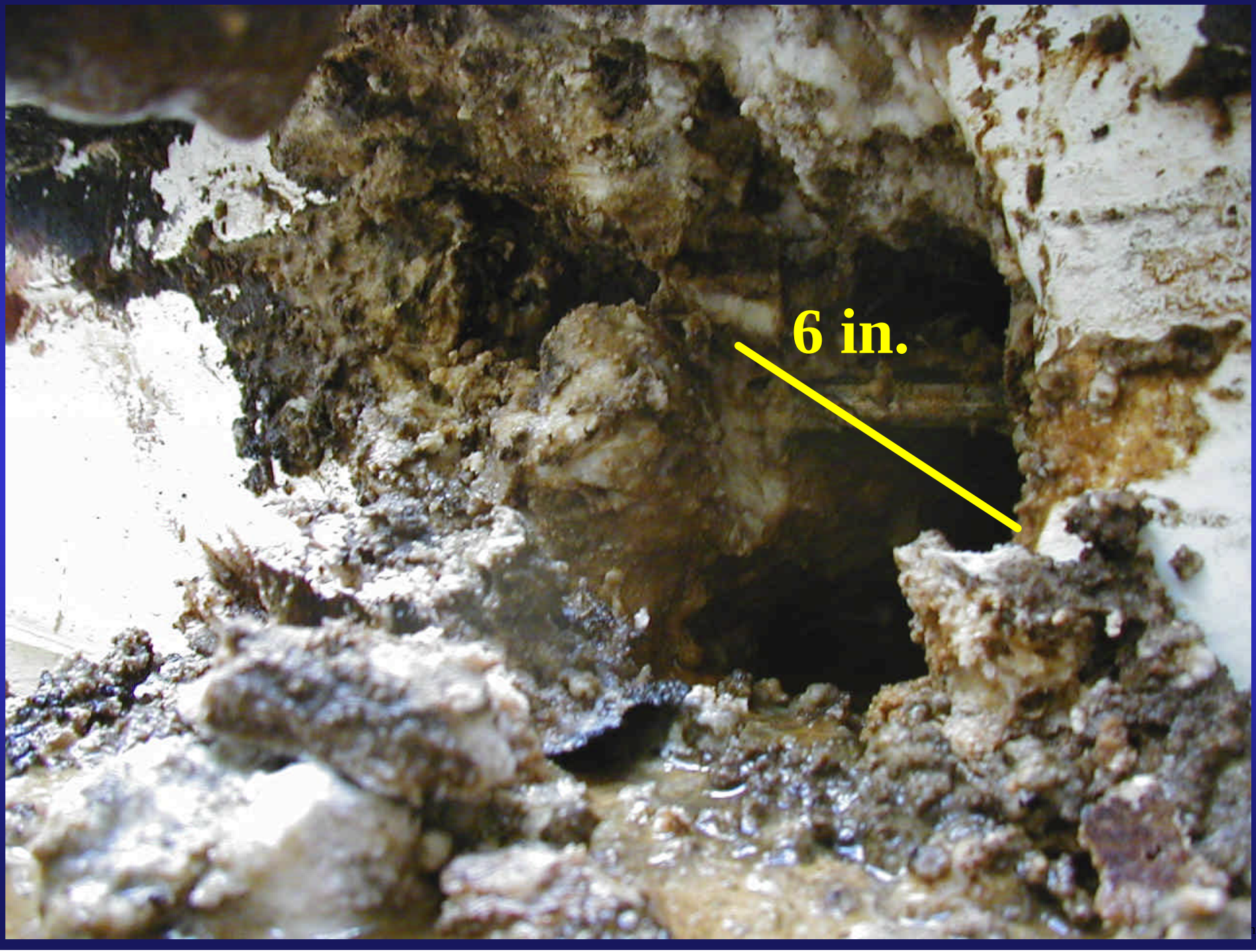
Item/Description	Costs
Interception trench well pump motor • L.E.: 2 yr • One spare retained in-stock	$900/motor
Bioreactor fixed-film PVC media replacement	$2500/chamber
Bioreactor effluent pump motor	$500/motor
Sand filter vessel and media replacement (500kg/vessel) • YR 5: Vessel - 6 to 10 yr; Media - 5 yr • YR 4: Vessel 3 yr; Media – 3 yr (due to excess throughput rate, throughput salinity and low quality backwash water	Vessels: $10,000 ($3500/vessel) Media: $1650 ($550/vessel)
GAC media replacement (900kg vessel) • YR 5 L.E.: 12 mo. • Year 4 L.E.: 2 mo. • Year 3 L.E.: 6 mo.	$3900 ($1950/vessel)
N_2 & P nutrient for microbes (four 200L drums) • 4 drums provide 10 to 12 mo. supply @ 65 to 85L/mo. • Consumption varies with throughput rate, contaminant load, precipitation, and temperatures	$1000 ($250/drum)

Corroded sand filter vessels

Fouled carbon

Toxicity Test Results Summary - 2000

Date	Fathead Minnow (% Survival)	Rainbow Trout Minnow (% Survival)
January	100	100
February	100	100
March	100	100
April	100	100
May	100	100
June	100	100
July	100	100
August	5	100
September	0	100
October	60	85
November	85	100
December	95	100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